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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S APPLICATION NO (If known, see 37 CFR 1 5 09/889920
INTERNATIONAL APPLICATION NO. PCT/JP99/01676	INTERNATIONAL FILING DATE 31 March 1999 (31.03.99)	PRIORITY DATE CLAIMED

TITLE OF INVENTION NON-DESTRUCTIVE INSPECTION METHOD AND APPARATUS THEREFOR

APPLICANT(S) FOR DO/EO/US ASANO, Toshio; SAKAI, Kaoru; TAGUCHIO, Tetsuo; and TANAKA, Isao

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND or SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [X] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [ ] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [X] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information:

See Attachment 1

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U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/889920	PCT/JP99/01676	520.40381X00

21. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):

		CALCULATIONS	PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a (2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**			
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**			
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**			
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**			
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**			
ENTER APPROPRIATE BASIC FEE AMOUNT =		$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		$ 0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	38 -20 =	18	**x $18.00**	$ 324.00	
Independent claims	15 -3 =	12	**x $80.00**	$ 960.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			**+ $270.00**	$ 270.00	
TOTAL OF ABOVE CALCULATIONS =				$ 2,414.00	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$ 0.00	
SUBTOTAL =				$ 2,414.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$ 0.00	
TOTAL NATIONAL FEE =				$ 2,414.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 40.00	
TOTAL FEES ENCLOSED =				$ 2,454.00	
				Amount to be refunded:	$
				charged:	$

a. [ ] A check in the amount of $ ________________ to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. ______________ in the amount of $ __________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 01-2135. A duplicate copy of this sheet is enclosed.

d. [X] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Melvin Kraus
Antonelli, Terry, Stout & Kraus, LLP
1300 North Seventeenth Street
Suite 1800
Arlington, VA 22209

Melvin Kraus
SIGNATURE

Melvin Kraus
NAME

22,466
REGISTRATION NUMBER

22/PRTS

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NON-DESTRUCTIVE INSPECTION METHOD AND APPARATUS THEREFOR

Technical Field

The present invention relates to a method of inspecting a deficiency, such as a crack in a metal surface, and, more particularly, to an inspection method for performing non-destructive inspections called penetrant inspection and magnetic-particle inspection and an apparatus therefor.

Background Art

A penetrant inspection and magnetic-particle inspection inspect a deficiency, such as a crack (crack) having an opening in the surface of metal in a non-destructive manner. In the penetrant inspection, normally, a red liquid called penetrant is applied to the surface to be inspected, the penetrant is wiped out after a predetermined time passes, and white powder called a developer is applied. If there is a deficiency, such as a crack, the penetrant remaining in the crack comes to the surface due to capillary phenomenon, indicating a deficiency in red. In case of magnetic-particle inspection, a solution containing fluorescent magnetic powder is sprayed on a specimen or a magnetic substance to magnetize the specimen. If there is a deficiency, such as a crack,

the magnetic flux is concentrated on the deficient portion, so that the fluorescent magnetic powder is gathered and emits green light when ultraviolet rays are irradiated, thereby showing a deficiency. Conventionally, those deficiency indications are observed visually to inspect deficiencies.

Such a visual inspection has a problem on the inspection reliability, such as missing of a deficiency due to the fatigue of an inspector or that different inspection results due to the difference in capability among inspectors are left merely by characters, such as "passed".

With regard to the magnetic-particle inspection, an automatic inspection apparatus has been developed for those parts which are important and are to be mass-produced. As it is a special-purpose apparatus, it cannot easily inspect parts having multifarious shapes.

Further, as the penetrant inspection needs to detect surface colors as a two-dimensional distribution at high precision, even if there is a colorimeter capable of accurately measuring the chromaticity at a point, two-dimensional sweeping is needed. In terms of inspection time and cost, therefore, it is difficult to easily perform automatic inspection of parts having multifarious shapes.

Furthermore, when a specimen was large, there were cases where it could not tell what part of the specimen the

image that was acquired by automatic inspection was or what part of the specimen the detected deficiency was.

Moreover, if both the penetrant inspection and magnetic-particle inspection can be done automatically by a single apparatus, the economical merit would be improved significantly, but such an apparatus and technology have not yet appeared so far.

It is therefore an object of the invention to provide a deficiency inspection method, a deficiency inspection apparatus and a deficiency-inspection aiding method which overcome the above-described problems and facilitate discrimination of real deficiencies.

It is also an object of the invention to provide a deficiency inspection method, a deficiency inspection apparatus and a deficiency-inspection aiding method which can easily find the position of a deficiency even on a large specimen.

Disclosure of Invention

The invention picks up a specimen using a color video camera. If a color video camera is used directly, however, it cannot pickup an image properly in the penetrant inspection because of the irradiation-oriented regular reflection light from the specimen. In the magnetic-particle inspection, illumination light (ultraviolet rays)

causes a foreign matter on the specimen to emit blue light, making it difficult to identify a deficiency. To eliminate the regular reflection light, therefore, a polarization filter is put in both the illumination and the camera. Further, a filter for cutting ultraviolet rays is placed in front of the camera.

As the color camera, a white illuminating lamp and an ultraviolet illuminating lamp are constructed as a single probe, it can be used both in the penetrant inspection and magnetic-particle inspection. In the penetrant inspection, xy chromaticities on the surface of the specimen are computed from a video signal from the color video camera to detect a red deficiency-indicating portion. In the magnetic-particle inspection, detection is made after differentiation is performed on a green video signal to highlight a deficiency.

To prevent overlooking and overdetection in automatic inspection, the inspection result is displayed in a color image and portions that have been determined as deficiencies in the automatic inspection are encircled in rectangular shapes so that an inspector checks the rectangular portions against the original images one by one to discriminate if they are real deficiencies. The original images and the inspection results are saved as recordings on a magneto-optical disk or the like.

When a specimen is like an elongated object which cannot be fitted in one field of view, the inspection position is specified by placing a scale in the pickup field of view and simultaneously picking up the scale and an image to be inspected.

Brief Description of Drawings

FIG. 1 is a diagram showing one example of an inspection target which is handled in the invention.

FIG. 2 is a structural diagram of a deficiency inspection apparatus showing one embodiment of the invention.

FIG. 3 is a diagram showing the effects of a polarization filter in the apparatus structure in FIG. 2, and FIG. 4 is a diagram showing the effects of an ultraviolet-rays cutting filter.

FIG. 5 is a flowchart illustrating the flow of an automatic inspection method in a penetrant inspection according to the invention.

FIG. 6 shows an xy chromaticity diagram.

FIG. 7 is a diagram showing a structure for camera calibration, and FIG. 8 is a diagram showing the flow of a camera calibration process.

FIG. 9 is a diagram illustrating a method of acquiring a reference white chromaticity from a chrominance image.

FIG. 10 is a diagram for explaining a method of computing a hue on a chromaticity diagram, FIG. 11 is a diagram for explaining a method of computing a chrominance on the chromaticity diagram, FIG. 12 is a diagram illustrating a method of acquiring a deficiency candidate area from the hue obtained in FIG. 10 and the chrominance obtained in FIG. 11, and FIG. 13 is a diagram illustrating a method of acquiring a deficiency area by discriminating a pseudo deficiency from the deficiency candidate area obtained in FIG. 12.

FIG. 14 is a diagram for explaining a method of acquiring a threshold value 135 to acquire a deficiency area by discriminating a pseudo deficiency from the deficiency candidate area shown in FIG. 13.

FIG. 15 is a diagram showing an example of an image processing algorithm in the magnetic-particle inspection of the invention, and FIG. 16 is a diagram for explaining a method of discriminating a pseudo deficiency in the magnetic-particle inspection of the invention.

FIG. 17 is a flowchart illustrating the process of confirming a deficiency and saving data in the invention.

FIG. 18 is a diagram exemplifying a method of generating a deficiency candidate marker according to the invention, and FIG. 19 is a diagram exemplifying a deficiency candidate displaying method according to the

invention.

FIG. 20 is a diagram showing one example of a method of specifying an inspection position in the invention, and FIG. 21 is a diagram showing one example of an inspection image which contains information for specifying the inspection position in the invention.

FIG. 22 is a diagram showing one example of the structure of inspection result data to be stored in a memory device 7.

Best Mode for Carrying Out the Invention

A preferred embodiment of the invention will now be described with reference to the accompanying drawings.

FIG. 1 shows one example of a deficiency which is inspected in the invention.

FIG. 1A shows one example of a penetrant inspection image, a white penetrant is applied to a specimen 1, a deficiency 2 (high contrast) and pseudo deficiencies 3 (low contrast) are observed. In the penetrant inspection, the deficiency 2 is highlighted as a red indicated pattern. The pseudo deficiencies appear when the penetrant stays in surface-polishing originated lines or the like and cannot be wiped out clean, and becomes a light red indicated pattern.

FIG. 1B shows one example of a magnetic-particle

inspection image, and it is assumed that a deficiency 2 exists on a specimen and fluorescent magnetic powder has already been applied and magnetized. When ultraviolet rays are illuminated on it, the fluorescent magnetic powder that has gathered on the deficiency 2 due to magnetization emits green light. If there is a welded portion in the specimen 1, for example, the fluorescent magnetic powder is gathered along welding beads so that green pseudo deficiencies 3 appear in some cases.

FIG. 2 is a structural diagram of a deficiency inspection apparatus according to the invention. There are a deficiency 2 and pseudo deficiencies 3 on a specimen 1. They are picked up by a color video camera 21. A white illuminating lamp 24a is turned on in inspecting a penetrant inspection image, whereas an ultraviolet illuminating lamp 24b is turned on in the magnetic-particle test. The white illuminating lamp 24a is connected to a white-illuminating-lamp connector 25a and is connected to an illumination power supply 8 by an illumination cable 26.

In the magnetic-particle inspection, the illumination cable 26 is connected to an ultraviolet-illuminating-lamp connector 25b. To avoid the influence of outside light, a hood 27 is attached. Although the illuminating lamp in use has a ring shape in FIG. 2, a single rod-shaped lamp or plural rod-shaped lamps may be used.

A color video signal from the color video camera 21 includes a type in which R, G and B are separated and a composite video signal. Either signal is stored as image data for R, G and B in a color image memory 4. The color image data is analyzed by a computer 5 and the results of deficiency detection are shown on a color monitor 6.

The deficiency inspection results are saved in a data memory device 7. Further, an image displayed on the color monitor 6 can be printed out from an unillustrated printer as needed.

A polarization filter 22a and an ultraviolet-rays cutting filter 22b are placed in front of the lens of the color video camera 21. A polarization filter plate 23 is provided under the white illuminating lamp 24a. The polarization filter 22a and the polarization filter plate 23 serve to prevent reflection of the illumination or regular reflection light from the specimen 1 in the inspection of the penetrant inspection image. While the output video image of the color video camera 21 is watched, the polarization filter 22a is turned and is fixed to the place where there is least image reflection or light reflection. The adjustment of the polarization filter 22a may be done automatically based on the video output signal of the color video camera 21.

The ultraviolet-rays cutting filter 22b serves to

inhibit unnecessary light emission from an adhered foreign matter caused by the ultraviolet illuminating lamp 24b.

FIG. 3 is a diagram showing the effects of the polarization filter 22a and the polarization filter plate 23.

FIG. 3A shows a state where there are no filters, and FIG. 3B shows a state where the filters are attached and the rotational angles of the filters are adjusted. In FIG. 3A, there is an illumination reflection 30, making deficiency detection difficult. The ring-like illumination reflection is on the assumption of a case where the white illuminating lamp 24a is ring-like. In FIG. 3B, this illumination reflection is gone.

FIG. 4 is a diagram showing the effects of the ultraviolet-rays cutting filter 22b. FIG. 4A shows a state where there are no filters, and FIG. 4B shows a state where the filters are attached. In FIG. 4A, light emission from a foreign matter 40, such as a little piece of thread, and regular reflection light 41 from the specimen are picked up by the color video camera 21, making deficiency detection difficult. In FIG. 4B, those noises are cut and the image shows only light emission by the fluorescent magnetic powder as in a case where the specimen 1 is visually observed by a man.

To begin with, a method of detecting a crack

deficiency in a penetrant inspection image will be explained with reference to FIGS. 5 through 13. FIG. 5 illustrates a method of automatically detecting the deficiency 2 in the penetrant inspection.

First, image pickup 50 of the specimen 1 on which a developer is applied is executed using the white illuminating lamp 24a. Next, chromaticity conversion 51 to acquire xy chromaticity values of individual pixels from acquired R, G and B color image data is executed.

Next, determination 52 of reference white to compute the reference white chromaticity of the developer is performed and computation 53 of the hue and chrominance at each position on the image with respect to the reference white is carried out.

Then, a region whose hue and chrominance lie within a specific range is extracted by binarization in order to execute extraction 54 of deficiency candidates.

A real deficiency 2 has a clear contour portion, and a pseudo deficiency often has an unclear contour portion. In this respect, differentiation 55 of the chrominance image is performed and the ratio of a change in chrominance of the contour portion of the extracted deficiency candidate area is obtained. Next, shape measuring 56 for the area, the aspect ratio, the length and so forth of the deficiency candidate area is performed. Then, a region whose ratio of

a change in chrominance and whose length and area are larger than specified ones is detected as the real deficiency 2 in detection 57 of deficiency. Further, the inspection results are displayed on the color monitor 6 and a deficiency is confirmed by an inspector, after which image data, shape data, positional information, etc. are saved in the data memory device 7 or printed out to be saved as a hardcopy 58.

In color-based inspection, it is necessary to evaluate colors quantitatively. In the step of chrominance conversion 51, therefore, RGB data of the picked-up color image is converted to chromaticities x, y and luminance Y that are specified by CIE (Commission internationale de l'.clairage), and inspection is carried out using them. Expression of chromaticities x, y in two-dimensional orthogonal coordinates is called a chromaticity diagram shown in FIG. 6. In the chromaticity diagram, individual colors are arranged around white and become clearer as they are located farther away from white. Hereinafter, the tone is called a hue, the clearness of each color is called a chromaticness and the distance between two chromaticities on the chromaticity diagram is called a chrominance. FIG. 6 shows a chromaticity range of a penetrant inspection image.

In this method, color calibration is executed

beforehand using a camera calibration color card 71 as shown in FIG. 7 in order to perform high-precision conversion of RGB data to chromaticities x, y and luminance Y. The flow of that process is shown in FIG. 8. The camera calibration color card 71 has three or more colors painted. The colors are picked up by the color video camera 21 (81), and the RGB values of the individual colors are computed (82). The chromaticities x, y and luminance Y are measured (83) by a colorimeter 72. The relationship between the RGB values and xyY values is expressed by equations (1) and equation (2).

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} R \\ B \\ G \end{pmatrix} \qquad \cdots (1)$$

where X, Y and Z are called three stimulus values.

$$\text{chromaticity: } x = \frac{X}{X+Y+Z} \quad y = \frac{Y}{X+Y+Z} \quad \text{luminance: } Y \quad \cdots (2)$$

The xyY values are computed by substituting the RGB values of the RGB values of the individual colors acquired from the camera into the equations (1) and (2) and conversion parameters specific to the camera are obtained

by acquiring a_{11} to a_{33} which make the values coincide with the xyY values measured by the colorimeter. As there are nine unknown parameters, the parameters can be computed from the RGB values (R_1, G_1, B_1) to (R_3, G_3, B_3) of at least three colors and their corresponding xyz values (x_1, y_1, Y_1) to (x_3, y_3, Y_3) from the colorimeter.

As it is apparent from the equation (2) that XYZ can be computed from the xyY values from the following equation (3),

$$X = Y \times x/y, \quad Y = Y, \quad Z = Y \times (1-x-y)/y \qquad (3)$$

XYZ are acquired by substituting the xyY values of the three colors from the colorimeter into the equation (3) and are substituted into the equation (1).

$$\begin{pmatrix} X_i \\ Y_i \\ Z_i \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} R_i \\ G_i \\ B_i \end{pmatrix} \qquad (i = 1, 2, 3) \cdots (4)$$

Accordingly, it is possible to acquire conversion parameters a_{11} to a_{33} specific to the camera (84) and acquire, from the RGB values from the camera, the xyY values that are equal to the values from the colorimeter.

Using the conversion parameters specific to the camera

that have been computed beforehand by calibration, the RGB values acquired from the camera are subjected to chromaticity conversion to xyY values and a chromaticity distribution in the image is computed, after which the chromaticity value of the developer or the chromaticity of a non-deficient portion in the image is computed as a reference value in 52. First, the chromaticities x, y of each pixel in the image are checked and the number of pixels that take x, y values as given in a graph in FIG. 9A is counted to prepare the two-dimensional chromaticity distribution of the chromaticities. Then, the x chromaticity value (FIG. 9B) and the y chromaticity value (FIG. 9C) for which there are the largest number of pixels in the image are acquired. As most of the image is a non-deficient portion, the x, y chromaticity values at the peak values in the two-dimensional chromaticity distribution become xy chromaticity values of the reference white.

In 53, the hue and chrominance at each position on the image with respect to the reference white are computed. Given that the chromaticity of the reference white is (x_c, y_c) and the chromaticity at the position (i, j) on the image is (x_{ij}, y_{ij}), the hue at the position (i, j) is computed in the direction toward the reference color on the chromaticity diagram as shown in FIG. 10. The computation equation is given in an equation (5).

hue: $\theta_{ij} = \left(\dfrac{y_{ij} - y_c}{x_{ij} - x_c} \right)$ ⋯ (5)

Further, the chrominance at the position (i, j) is computed in terms of a distance from the reference color on the chromaticity diagram as shown in FIG. 11. The computation equation is given in an equation (6).

chrominance: $d_{ij} = \sqrt{(x_{ij} - x_c)^2 + (y_{ij} - y_c)^2}$ ⋯ (6)

From the hue and chrominance at each position of the image with respect to the reference white computed in the above-described manner, the range that is wanted to be detected as a deficiency is limited by the hue (in the diagram, the range of the hue θ is $\theta_1 \leqq \theta \leqq \theta_2$), and the degree of a difference in clearness of the color and the reference white is limited by the chrominance (in the diagram, the range of the chrominance d is $d_1 \leqq d \leqq d_2$). And, portions which lie within this range are extracted as deficiency candidate areas.

Some of the deficiency candidates that have been acquired through the limitation with the hue and chrominance may not be needed to be detected as deficiencies. For example, a portion whose chromaticity

gradually changes with respect to the reference white is not a deficiency, but an area which has a clear contour is a deficiency. Therefore, a portion whose color changes gently with respect to the ambient colors is considered as a normal portion or pseudo deficiency 3, and a portion whose color changes sharply is considered as a deficiency 2. In (55), the amounts of a change in chrominance with respect to the reference white are acquired for deficiency candidate areas and only the area whose value is equal to or greater than a given value is considered as a deficiency.

A description will be given with reference to FIG. 13. FIG. 13A shows deficiency candidate areas 131 extracted in 54. 133 in FIG. 13B is a graph of chrominance with respect to the reference white on 132 in FIG. 13A. Further, the amount of a change in the chrominance 133 at each position on 132 or differentiation of 133 is a chrominance differentiation distribution 134 in FIG. 13D. Apparently, an area which has a small amount of a change in chrominance with respect to the reference white has a small differential value. As indicated in (d), an area whose differential value is larger than a given value 135 is considered as a deficiency area. As a result, only a deficiency area 136 which has a large chrominance and has a large amount of a change in chrominance or has a clear contour as in FIG. 13C is detected.

A method of determining the threshold value 135 will now be discussed with reference to FIG. 14. In a graph in FIG. 14A, the vertical axis is the maximum value in the chrominances in each deficiency candidate area extracted by the hue and chrominance, the horizontal axis is the maximum value in the differential values of the chrominance at the contour portion of each deficiency candidate area, and the values for the real deficiency 2 are plotted by × and the values for the pseudo deficiency 3 are plotted by ○. 141a is a degree distribution of the individual chrominance differential values and 142a is a degree distribution of the chrominance values. When a deficiency is clearly distinguished from a pseudo deficiency, a decision line 144a should be a straight line 144a that passes the bottom peaks in the degree distributions 141a and 142a and is perpendicular to a main axis 143a of inertia at the plotted points. When a deficiency is not distinguished from a pseudo deficiency, a decision line should be 144b as shown in FIG.14B. That is, all deficiency candidate areas are detected as deficiencies to avoid any overlooking and missing.

A deficiency detection method in the magnetic-particle inspection will now be described using FIGS. 15 and 16.

FIG. 15 shows an example of an image processing algorithm to analyze the contents of the data memory device

7 in the magnetic-particle inspection. Acquisition of an RGB image is performed (151), then differentiation of a G image which contains the largest amount of emission information of the fluorescent magnetic powder is performed (152). This highlights a portion, such as a crack deficiency, which has a large linear change in luminance Y, and does not highlight a portion, such as a portion where magnetic powder stays, which has a high luminance but has a small change in luminance.

Next, a threshold value for binarization is determined from the average value of the G differential image and binarization is performed (153). An image noise, such as an isolated point, is removed from the binarized image (154), then deficiency candidates are acquired, after which the lengths, contrasts and so forth of those deficiency candidates are computed (155). When those values are larger than specified values, they are determined as deficiencies.

FIG. 16 shows a method of discriminating a deficiency from a pseudo deficiency. When the luminance distributions of the deficiency 2 and the pseudo deficiency 3 are taken on a line 161 as shown in FIG.16A, for example, a luminance distribution 162 as shown in FIG.16B is acquired. The luminance values of the deficiency 2 and the pseudo deficiency 3 are about the same. Differentiating the

luminance distribution 162 yields a luminance differential distribution 163 as shown in FIG.16B. As the luminance of the deficiency 2 changes drastically and the luminance of the pseudo deficiency 3 changes slowly, only the deficiency 2 can be extracted as in FIG.16C by determining the results of the differentiation using a decision threshold value 164 of FIG.16D.

With reference to FIG. 17, confirmation of a deficiency and data saving will be explained. Although a deficiency should have been distinguished from a pseudo deficiency and only a deficiency should have been extracted, visual confirmation of a deficiency is executed last in both the penetrant inspection and the magnetic-particle inspection in order to prevent missing or erroneous determination.

FIG. 17 is a flowchart illustrating the process of confirming a deficiency. First, a marker of a deficiency candidate is shown on the portion which has been determined as a deficiency in the automatic determination (171). Next, the computer 5 request an inspector to determine deficiency candidates one by one (172). The inspector determines if it is a real deficiency while viewing the color original image (173). When the inspector recognizes it as a real deficiency, the position, length, contrast and so forth of the deficiency are registered in the data memory device 7

(174) and the color of the marker is turned to red (175).

When the inspector determines the portion as a deficiency candidate in the confirmation of the deficiency candidate, the marker is erased (176). If there remains a deficiency candidate, the marker is given on the next deficiency candidate. When confirmation of all the deficiency candidates is completed (177), the color original image is saved in the data memory device 7 (178).

FIG. 18 exemplifies a method of generating a deficiency candidate marker. A center line 182 which connects a beginning point P1 and an end point P2 of a deficiency candidate 181 is acquired, and long sides AB and CD of a deficiency candidate marker 183 are set in parallel to and apart from the center line by a given value m. Short sides AD and BC are likewise determined. The length of the deficiency is a distance between P1 and P2. In case of the magnetic-particle inspection, the contrast that is related to the depth of the deficiency is acquired by scanning a contrast computation line 184 from P1 to P2, acquiring a difference between an average luminance and a highest luminance on this line, acquiring this difference from P1 to P2, and setting an average value of the differences as the contrast of the deficiency. The deficiency candidate marker should not necessarily be rectangular. The short sides AD and BC may be made

semicircles; the key point is that a deficiency should not be hidden by the marker.

FIG. 19 exemplifies a method of displaying a deficiency candidate on the color monitor 6. The inspector is requested to confirm candidates on the original image in order from a candidate whose deficiency length is long. First, all the markers are displayed in white, the marker of the candidate which has been determined as a real deficiency is changed to another color, e.g., red, and the marker of the candidate which has been determined as a pseudo deficiency is erased.

FIG. 20 shows one example of a method of specifying an inspection position when the specimen 1 is an elongated object. A scale 201 with graduations is fixed to the specimen 1 and image pickup is carried out in such a way that the scale 201 comes into a part of a camera's visual field 202. The graduations of the scale may be made by writing numerals, for example, every centimeter. Further, the scale 201 for the penetrant inspection may be made different in color from the scale 201 for the magnetic-particle inspection. In the magnetic-particle inspection, for example, the numerals on the scale are graduations and numerals in fluorescent green color on the white background.

FIG. 21 shows one example of a picked-up screen. The scale 201 is picked up at the lower portion of the screen

at the same time, and the camera position on the specimen 1 is computed from the scale 201. That is, graduation numerals 210 are described on the scale 201 and can be identified by pattern matching or the like using the computer 5. The scale 201 has segmentation lines 211, for example, every centimeter, so that the finer camera position can be computed. A cross-section signal 213 is acquired as an image signal of an inspection line 212 between C1 and C2 on the image. From the signal, a left-hand end A and a right-hand end B of the image and the positions of 16-20 of the segmentation lines 211 are known. The image pickup magnification can be computed from the positions of 16-20, and the accurate position of the deficiency 2 on the specimen 1 can be known based also on the graduation numerals 210.

The above-described inspection results are stored in the memory device 7, and an example of the storage is illustrated in FIG. 22. When the specimen 1 has a large surface to be inspected and the whole to-be-inspected surface cannot fit in a single inspection screen, it is segmented into several images before image pickup and inspection are carried out. At this time, the images to be segmented are set in such a way that the pickup ranges on the inspection surface overlap one another a little. 221a, 221b and 221c indicate image segments of the specimen 1.

Inspection is performed on each image segment. The results or the entire image information for each specimen is stored together and information of each deficiency, such as the position, length, area, chromaticity and hue, is also stored as shown in 222.

The inspector first displays the data 222 for each specimen stored in the memory device 7 on the screen of the monitor 6 and checks it. When the inspector wants to see the details of the portion where a deficiency exists, he calls a corresponding image segment from the name of the specimen and the image No. and displays it on the screen of the monitor 6. At this time, information, such as the position, length, area, chromaticity and hue of a deficiency, which is stored in association with the displayed image data can also be displayed on the screen of the monitor 6.

Highlighting the detected deficiency candidate on the screen using a marker or the like can prevent overlooking of a deficiency, on the screen, which is larger than 0.1 to 0.3 mm of the same degree as that in the visual inspection done conventionally.

Further, increasing the image detection magnification can permit a deficiency smaller than a visible one to be detected. Displaying a deficiency smaller than a visible one on the screen in magnified manner can allow the

position, length, area, chromaticity, hue, etc. of even a deficiency smaller than a visible one to be confirmed on the screen.

As an image is input using a color video camera according to the invention and ultraviolet rays reflected from a specimen can be cut by the ultraviolet-rays cutting filter in deficiency inspection by the magnetic-particle inspection method, an inspector can easily confirm the results of the automatic deficiency inspection. Further, because a deficiency candidate is automatically indicated and displayed on the screen, miss-inspection hardly occurs. What is more, as the inspected image is saved, it is possible to display the image saved after inspection on the screen and check a deficiency again, thus improving the inspection reliability.

As a color video camera is used in the invention, automatic deficiency inspections of the magnetic-particle inspection and penetrant inspection can be executed by the same sensor probe, so that the usability is improved considerably.

CLAIMS

1. A deficiency inspection method based on a magnetic-particle inspection scheme, wherein a to-be-inspected surface of a specimen is picked up using a color video camera and a deficiency on said to-be-inspected surface is inspected using an image acquired by that image pickup.

2. The deficiency inspection method according to claim 1, wherein a deficiency on said to-be-inspected surface of a specimen is picked up using a color video camera and a deficiency on said to-be-inspected surface is inspected using a green (G) signal component in signals of primary colors of RGB in said image picked up by said color video camera.

3. A deficiency inspection method based on a magnetic-particle inspection scheme, wherein a to-be-inspected surface of a specimen to which a solution containing fluorescent magnetic powder is applied is irradiated with ultraviolet rays, said to-be-inspected surface irradiated with ultraviolet rays is picked up by a color video camera, and an image acquired by that image pickup is displayed on a screen in a nearly same state as an image acquired by visually observing said to-be-inspected surface irradiated with ultraviolet rays.

4. A deficiency inspection method based on a

magnetic-particle inspection scheme, wherein a to-be-inspected surface of a specimen to which a solution containing fluorescent magnetic powder is applied is irradiated with ultraviolet rays, said to-be-inspected surface irradiated with ultraviolet rays is picked up by a color video camera via an ultraviolet-rays cutting filter, a deficiency and deficiency candidates are extracted from an image acquired by that image pickup, and images of said extracted deficiency and deficiency candidates are displayed on a screen.

5. A deficiency inspection method based on a penetrant inspection scheme, wherein a to-be-inspected surface of a specimen is picked up using a color video camera and a deficiency on said to-be-inspected surface is inspected using an image acquired by that image pickup.

6. A deficiency inspection method based on a penetrant inspection scheme, wherein a to-be-inspected surface of a specimen is illuminated with polarization light, said to-be-inspected surface illuminated with polarization light is picked up by a color video camera via a polarization filter, a deficiency and deficiency candidates are extracted from an image acquired by that image pickup, and images of said extracted deficiency candidates are displayed.

7. A deficiency inspection method based on a probing

scheme, wherein a to-be-inspected surface of a specimen is picked up by a color video camera with positional information of a visual field of said color video camera placed in said visual field, deficiency candidates in said to-be-inspected surface are extracted from an image acquired by that image pickup, and images of said extracted deficiency candidates are displayed on a screen together with said positional information of said visual field.

8. The deficiency inspection method according to claim 7, wherein said positional information of said visual field is originated from a scale arranged in said visual field.

9. The deficiency inspection method according to any one of claims 1 to 8, wherein said to-be-inspected surface is picked up by said color video camera over plural visual fields.

10. A deficiency inspection method based on a probing scheme, wherein a to-be-inspected surface of a specimen is picked up by image pickup means, deficiency candidates in said to-be-inspected surface are extracted from an image acquired by that image pickup, images of said extracted deficiency candidates are displayed on a screen, and a pseudo deficiency is eliminated from said displayed images of said deficiency candidates.

11. A deficiency inspection method based on a probing

scheme, wherein a to-be-inspected surface of a specimen is picked up by image pickup means, deficiency candidates in said to-be-inspected surface are extracted from an image acquired by that image pickup, images of said extracted deficiency candidates are displayed on a screen, and information about a deficiency selected from said images of said displayed deficiency candidates is stored.

12. A deficiency inspection apparatus based on a probing scheme, comprising: illumination means for illuminating a to-be-inspected surface of a specimen; image pickup means for picking up said to-be-inspected surface by a color video camera; deficiency-candidate extraction means for extracting deficiency candidates on said to-be-inspected surface from an image of said to-be-inspected surface acquired by image pickup by said image pickup means; and display means for displaying images of said deficiency candidates extracted by said deficiency-candidate extraction means.

13. The deficiency inspection apparatus according to claim 12, wherein said illumination means has an ultraviolet-rays illuminating section for illuminating ultraviolet rays onto said to-be-inspected surface of said specimen, and a white-light illuminating section for illuminating white light onto said to-be-inspected surface of said specimen.

14. A deficiency inspection apparatus based on a probing scheme, comprising: illumination means for illuminating a to-be-inspected surface of a specimen; image pickup means for picking up said to-be-inspected surface by a color video camera; magnetic-particle-inspection-originated deficiency-candidate extraction means for extracting magnetic-particle-inspection originated deficiency candidates on said to-be-inspected surface from an image of said to-be-inspected surface acquired by that image pickup by said image pickup means; penetrant-inspection-originated deficiency-candidate extraction means for extracting penetrant-inspection-originated deficiency candidates on said to-be-inspected surface from said image of said to-be-inspected surface acquired by image pickup by said image pickup means; and display means for displaying images of said deficiency candidates extracted by said magnetic-particle-inspection-originated deficiency-candidate extraction means or said penetrant-inspection-originated deficiency-candidate extraction means.

15. A deficiency inspection apparatus based on a probing scheme, comprising: illumination means for illuminating a to-be-inspected surface of a specimen; image pickup means for picking up said to-be-inspected surface by a color video camera; deficiency-candidate extraction means for extracting deficiency candidates on said to-be-

inspected surface from an image of said to-be-inspected surface acquired by image pickup by said image pickup means; a storage section for storing images of said deficiency candidates extracted by said deficiency-candidate extraction means; and display means for displaying information of said images of said deficiency candidates stored in said storage section on a screen.

16. A deficiency inspection apparatus based on a probing scheme, comprising: ultraviolet-rays irradiation means for irradiating ultraviolet rays to a to-be-inspected surface of a specimen to which a solution containing fluorescent magnetic powder is applied; image pickup means for picking up said to-be-inspected surface irradiated with ultraviolet rays by said ultraviolet-rays irradiation means by a color video camera; and display means for displaying an image of said to-be-inspected surface acquired by image pickup by said image pickup means on a screen in a nearly same state as an image acquired by visually observing said to-be-inspected surface irradiated with ultraviolet rays.

17. A deficiency inspection apparatus based on a probing scheme, comprising: ultraviolet-rays irradiation means for irradiating ultraviolet rays to a to-be-inspected surface of a specimen to which a solution containing fluorescent magnetic powder is applied; image pickup means for picking up said to-be-inspected surface irradiated with

ultraviolet rays by said ultraviolet-rays irradiation means by a color video camera via an ultraviolet-rays cutting filter; deficiency-candidate extraction means for detecting deficiency candidates on said to-be-inspected surface from an image of said to-be-inspected surface acquired by image pickup by said image pickup means, and display means for displaying images of said deficiency candidates extracted by said deficiency-candidate extraction means.

18. A deficiency inspection apparatus based on a probing scheme, comprising: ultraviolet-rays irradiation means for irradiating ultraviolet rays to a to-be-inspected surface of a specimen to which a solution containing fluorescent magnetic powder is applied; image pickup means for picking up a fluorescent image of said to-be-inspected surface irradiated with ultraviolet rays by said ultraviolet-rays irradiation means by a color video camera; deficiency-candidate extraction means for extracting deficiency candidates on said to-be-inspected surface using a green (G) signal component in a color image signal output from said image pickup means; and display means for displaying images of said deficiency candidates extracted by said deficiency-candidate extraction means.

19. A deficiency inspection apparatus based on a probing scheme, comprising: illumination means for illuminating a to-be-inspected surface of a specimen to

which a penetrant is temporarily applied with white light; image pickup means for picking up said to-be-inspected surface by a color video camera; magnetic-particle-inspection-originated deficiency-candidate extraction means for extracting magnetic-particle-inspection originated deficiency candidates on said to-be-inspected surface from an image of said to-be-inspected surface acquired by that image pickup by said image pickup means; penetrant-inspection-originated deficiency-candidate extraction means for extracting penetrant-inspection-originated deficiency candidates on said to-be-inspected surface from said image of said to-be-inspected surface acquired by image pickup by said image pickup means; and display means for displaying images of said deficiency candidates extracted by said magnetic-particle-inspection-originated deficiency-candidate extraction means or said penetrant-inspection-originated deficiency-candidate extraction means.

20. The deficiency inspection apparatus according to any one of claims 12 to 19, wherein positional information display means for displaying positional information of a visual field of said color video camera is arranged in said visual field.

21. The deficiency inspection apparatus according to claim 20, wherein said positional information display means is a scale.

FIG. 1A

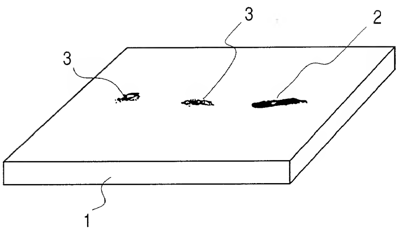


FIG. 1B

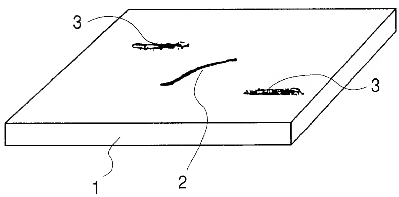


FIG. 2

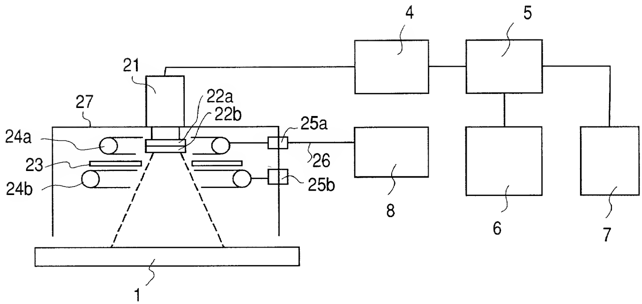


FIG. 3A

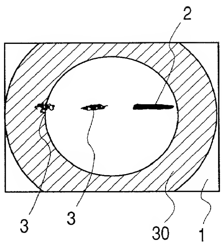


FIG. 3B

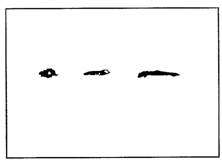


FIG. 4A

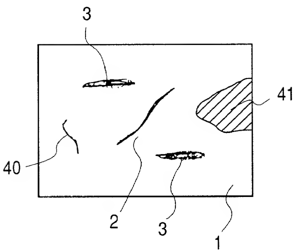


FIG. 4B

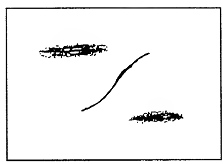


FIG. 5

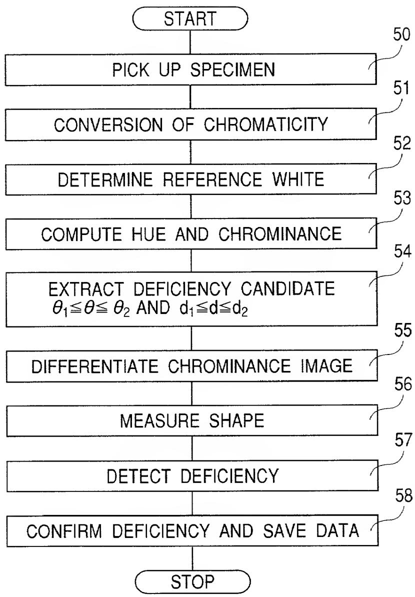
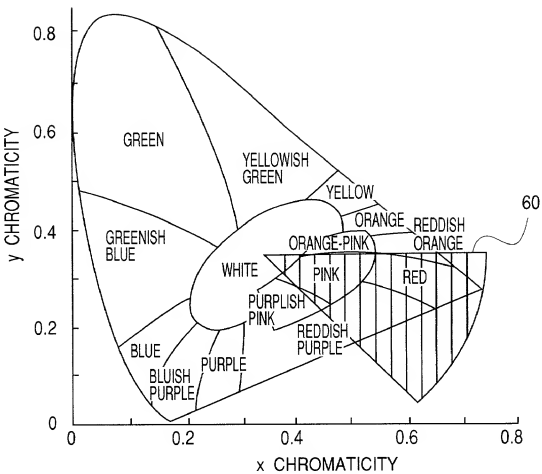

START
PICK UP SPECIMEN
50
CONVERSION OF CHROMATICITY
51
DETERMINE REFERENCE WHITE
52
COMPUTE HUE AND CHROMINANCE
53
EXTRACT DEFICIENCY CANDIDATE
$\theta_1 \leqq \theta \leqq \theta_2$ AND $d_1 \leqq d \leqq d_2$
54
DIFFERENTIATE CHROMINANCE IMAGE
55
MEASURE SHAPE
56
DETECT DEFICIENCY
57
CONFIRM DEFICIENCY AND SAVE DATA
58
STOP

FIG. 6


0.8
0.6
0.4
0.2
0
y CHROMATICITY
GREEN
YELLOWISH GREEN
YELLOW
ORANGE
REDDISH ORANGE
60
GREENISH BLUE
ORANGE-PINK
WHITE
PINK
RED
PURPLISH PINK
REDDISH PURPLE
BLUE
BLUISH PURPLE
PURPLE
0
0.2
0.4
0.6
0.8
x CHROMATICITY

09/889920

FIG. 7

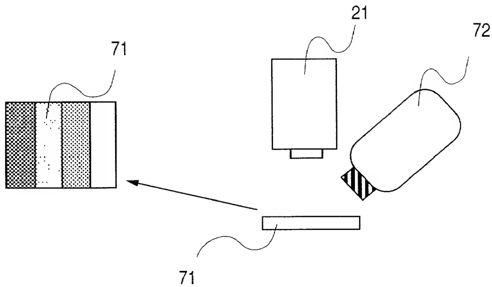
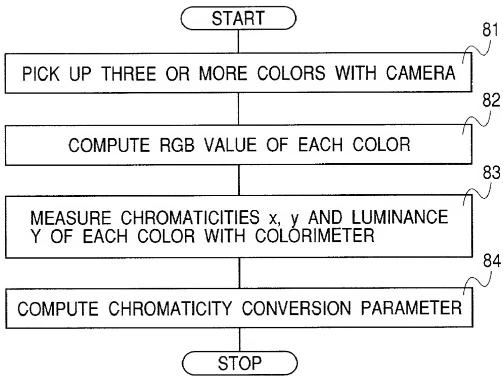


FIG. 8


START
81
PICK UP THREE OR MORE COLORS WITH CAMERA
82
COMPUTE RGB VALUE OF EACH COLOR
83
MEASURE CHROMATICITIES x, y AND LUMINANCE Y OF EACH COLOR WITH COLORIMETER
84
COMPUTE CHROMATICITY CONVERSION PARAMETER
STOP

09/889920

FIG. 9A

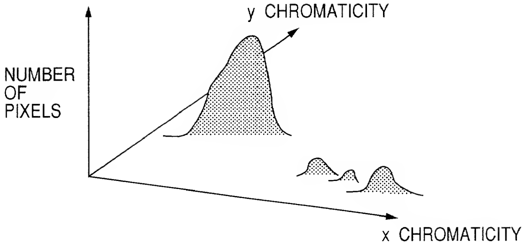


FIG. 9B

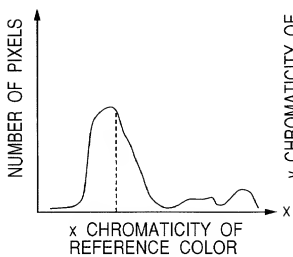


FIG. 9C

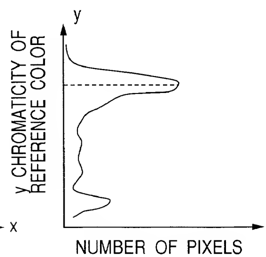
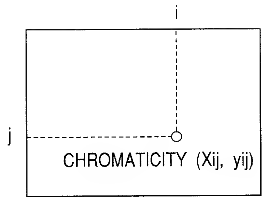
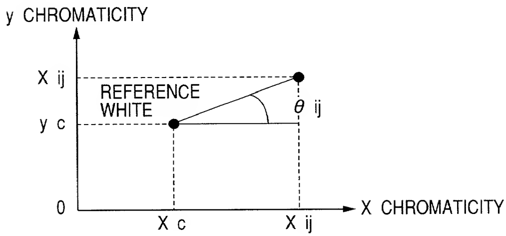
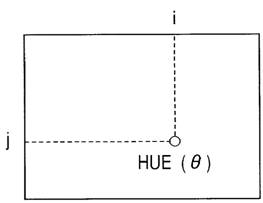


FIG. 10



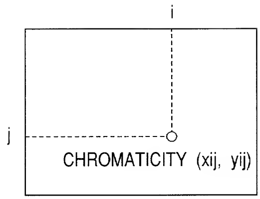
CHROMATICITY IMAGE



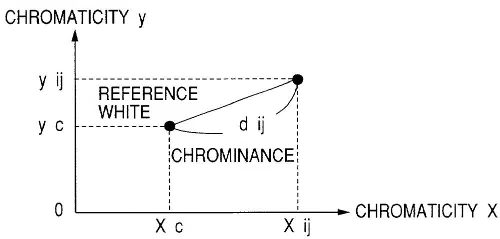


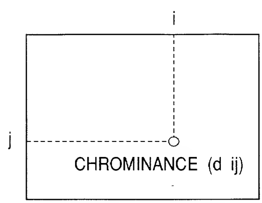
HUE IMAGE

FIG. 11



CHROMATICITY IMAGE





CHROMINANCE IMAGE

FIG. 12

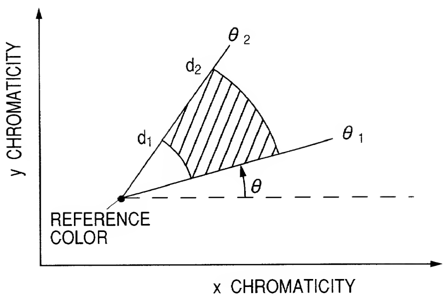


FIG. 13A

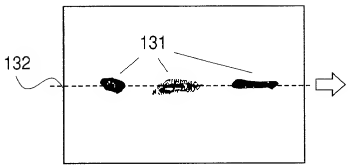


FIG. 13C

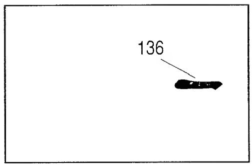


FIG. 13B

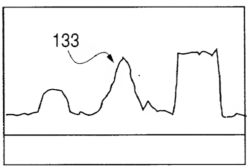
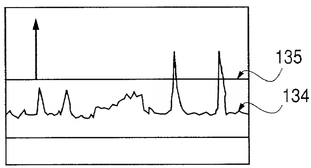


FIG. 13D



09/889920

FIG. 14A

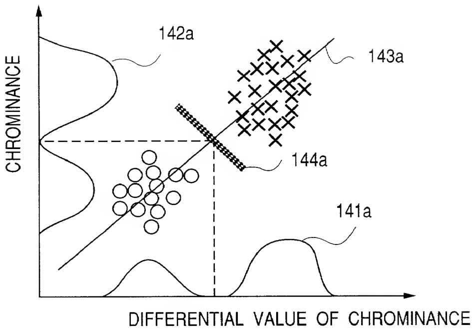


FIG. 14B

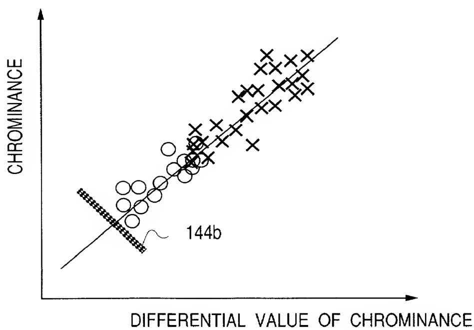


FIG. 15

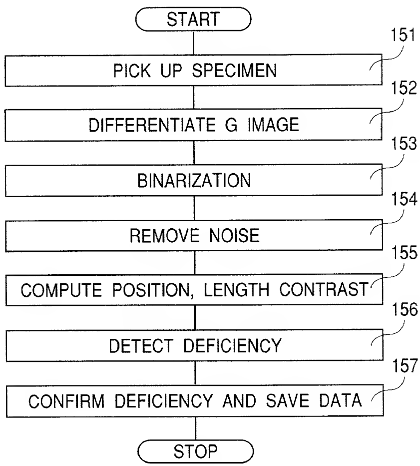

START
PICK UP SPECIMEN
151
DIFFERENTIATE G IMAGE
152
BINARIZATION
153
REMOVE NOISE
154
COMPUTE POSITION, LENGTH CONTRAST
155
DETECT DEFICIENCY
156
CONFIRM DEFICIENCY AND SAVE DATA
157
STOP

FIG. 16A

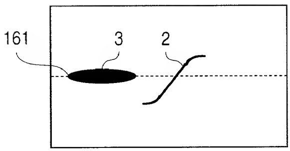


FIG. 16C

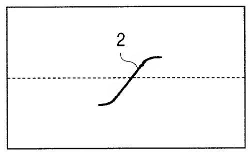


FIG. 16B

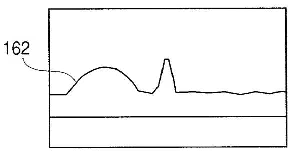


FIG. 16D

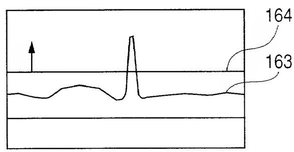


FIG. 17

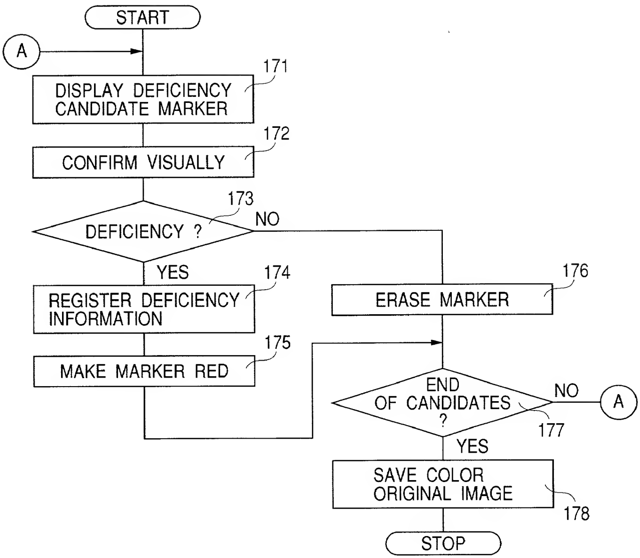

START
A
DISPLAY DEFICIENCY CANDIDATE MARKER
171
CONFIRM VISUALLY
172
DEFICIENCY ?
173
NO
YES
REGISTER DEFICIENCY INFORMATION
174
MAKE MARKER RED
175
ERASE MARKER
176
END OF CANDIDATES ?
177
NO
A
YES
SAVE COLOR ORIGINAL IMAGE
178
STOP

FIG. 18

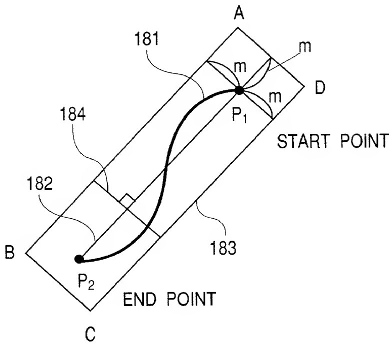


FIG. 19

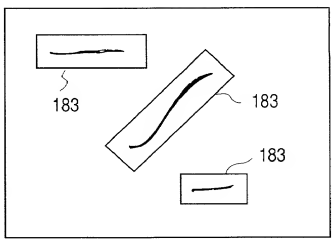


FIG. 20

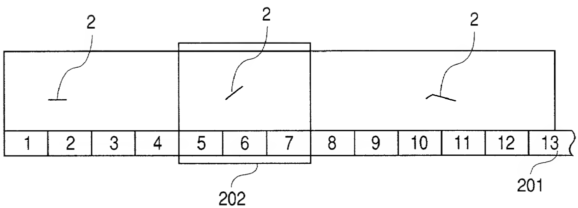


FIG. 21

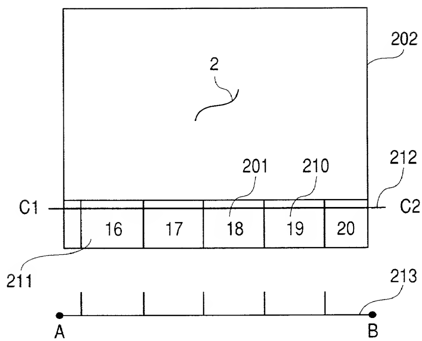
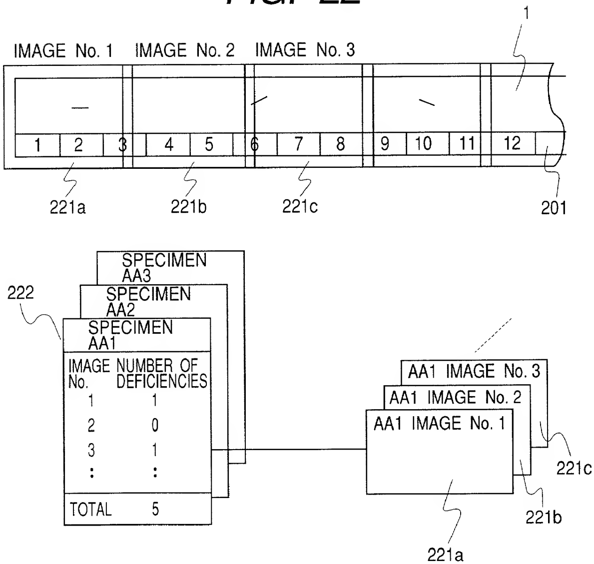


FIG. 22



1
IMAGE No. 1
IMAGE No. 2
IMAGE No. 3
1
2
3
4
5
6
7
8
9
10
11
12
221a
221b
221c
201
222
SPECIMEN AA3
SPECIMEN AA2
SPECIMEN AA1
IMAGE No.
NUMBER OF DEFICIENCIES
1 1
2 0
3 1
: :
TOTAL 5
AA1 IMAGE No. 3
AA1 IMAGE No. 2
AA1 IMAGE No. 1
221c
221b
221a

NT0399US

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Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

NON-DESTRUCTIVE INSPECTION METHOD AND APPARATUS THEREFOR

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

The specification of which is attached hereto unless the following box is checked:

☐ __月__日に提出され、米国出願番号または特許協定条約国際出願番号を__________とし、
(該当する場合) __________に訂正されました。

☐ was filed on 31/March/1999
as United States Application Number or
PCT International Application Number
PCT/JP99/01676 and was amended on
__________ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第３７編第１条５６項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Japanese Language Declaration
(日本語宣言書)

私は、米国法典第３５編１１９条 (a) - (d) 項又は３６５条 (b) 項に基き下記の、 米国以外の国の少なくとも一カ国を指定している特許協力条約３６５ (a) 項に基ずく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示している。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Not Claimed 優先権主張なし
			☐
			☐

私は、第３５編米国法典１１９条 (e) 項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

私は、下記の米国法典第３５編１２０条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約３６５条 (c) に基ずく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第３５編１１２条第１項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第３７編１条５６項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

私は、私自身の知識に基ずいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基ずく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第１８編第１００１条に基ずき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

PTO/SB/106(8-96) (Modulated spacing)
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Japanese Language Declaration
(日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

9—

Donald R. Antonelli, Reg. No. 20,296; David T. Terry, Reg. No. 20,178; Melvin Kraus, Reg. No. 22,466; William I. Solomon, Reg. No. 28,565; Gregory E. Montone, Reg. No. 28,141; Ronald J. Shore, Reg. No. 28,577; Donald E. Stout, Reg. No. 26,422; Alan E. Schiavelli, Reg. No. 32,087; James N. Dresser, Reg. No. 22,973 and Carl I. Brundidge, Reg. No. 29,621

書類送付先

Send Correspondence to:

Antonelli, Terry, Stout & Kraus, LLP
Suite 1800
1300 North Seventeenth Street
Arlington, Virginia 22209

直接電話連絡先： (氏名及び電話番号)

Direct Telephone Calls to: (*name and telephone number*)

Telephone: (703) 312-6600
Fax: (703) 312-6666

唯一または第一発明者		Full name of sole or first inventor Toshio ASANO
発明者の署名	日付	Inventor's signature Toshio Asano Date 6/20/01
住所		Residence Yokohama, Japan JPX
国籍		Citizenship Japan
私書箱		Post Office Address c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan

（第二以降の共同発明者についても同様に記載し、署名をすること）

(Supply similar information and signature for second and subsequent joint inventors.)

第二共同発明者 2-00	Full name of second joint inventor, if any Kaoru SAKAI
第二共同発明者の署名 日付	Second inventor's signature Date Kaoru Sakai 6/18/01
住所	Residence Yokohama, Japan JPX
国籍	Citizenship Japan
私書箱	Post Office Address c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan
第三共同発明者 3-00	Full name of third joint inventor, if any Tetsuo TAGUCHI
第三共同発明者の署名 日付	Third inventor's signature Date Tetsuo Taguchi 6/29/01
住所	Residence Hitachi, Japan JPX
国籍	Citizenship Japan
私書箱	Post Office Address c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan
第四共同発明者 4-00	Full name of fourth joint inventor, if any Isao TANAKA
第四共同発明者の署名 日付	Fourth inventor's signature Date Isao Tanaka 6/25/01
住所	Residence Hitachi, Japan JPX
国籍	Citizenship, Japan
私書箱	Post Office Address c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan
第五共同発明者	Full name of fifth joint inventor, if any
第五共同発明者の署名 日付	Fifth inventor's signature Date
住所	Residence
国籍	Citizenship
私書箱	Post Office Address

(第六以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for sixth and subsequent joint inventors.)